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- Breevoort, C.M.
Universal Communications Technology, L.L.C.

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A Multi-services Communications Architecture For In-home USB and IEEE-1394 Based Devices

C. M. Breevoort, Ph.D.
President
Universal Communications Technology, L.L.C.
uctllc@aol.com

ABSTRACT

This paper discusses a flexible in-home communications architecture interfacing external networks to Universal Serial Bus (USB) and IEEE-1394 High Performance Serial Bus based end-terminal devices. A smart network interface unit (NIU), or residential gateway, functions as the bridge between outside networks, namely telephony and coaxial cable plants, and existing in-home wiring formed by telephone lines, coax cable, and power lines. The USB and IEEE-1394 based end-terminal devices connect to the in-home wiring through wiring termination nodes (WTN) or cable termination nodes (CTN). The WTN and CTN communicate with the NIU and are basically hubs with a modified upstream port.

INTRODUCTION

Possible future home services, such as energy management, home security, digital audio, home automation, electronic games, and others not imagined yet, require different amounts of data with various data rates and protocols. In a PC-centric architecture, whereby a modem forms the gateway to external networks, support for these services is possible, but will have many serious drawbacks. These services are not even possible at subscriber's sites without a PC or with a powered-down PC. Presently, no clear approach exists to link outside networks with in-home networks or new classes of digital end-terminal devices.

The Multimedia Cable Network Systems (MCNS) Data Over Cable Service Interface Specification (DOCSIS) demonstrates the cable industries desire to define interoperable cable modems. It allows for the first time high-speed, two-way communications between an in-home PC and the head-end in a hybrid fiber-coax (HFC) network, and extends the typical cable communications system analog broadcast service. Phone companies will follow with similar high-speed modem efforts using the telephone network.

The computer industry is working with many consumer electronics companies to ensure compatibility among future products. Adoption of the Universal Serial Bus (USB) and the IEEE-1394 High Performance Serial Bus in computer equipment and consumer end-terminal devices, such as TVs, VCRs, set-top boxes, and cameras, will make interconnection transparent. At the same time, the Video Electronics Standards Association (VESA) Home Network Committee is active setting standards for distribution of information inside the home from one device to any other device. A long-distance version of the IEEE-1394 has been proposed as the backbone. Several standards exist for communication over power lines, such as the Consumer Electronics (CE) and the popular X-10 protocol.

This paper will show a cost-effective approach for cable or telephone companies to provide the gateway to the home using the existing home wiring. With the proper modifications to a network interface unit (NIU) at a home the residential gateway can form the bridge to the home networks. The paper embraces the USB and the IEEE-1394 bus modified for coax cable and phone wiring for in-home network protocols. It recommends an architecture for an integrated multi-service communications communications system that extends the head-end or central office to numerous end-terminal devices inside the home attached to different physical media. The NIU passes all signals, including the analog broadcast signals, in the downstream direction on the coax cable. The NIU re-modulates downstream, low-speed data to an area in the 5-40 MHz band over the in-home coaxial cable network to inexpensive cable termination nodes (CTN), or transmits data via copper wiring to wiring termination nodes (WTN). The CTN and WTN are basically USB or IEEE-1394 hubs with a modified upstream port. The NIU concentrates the upstream data packets received from end-terminal devices or in-home networks and transmits them upstream.

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IMPLEMENTATION

The adoption of USB and IEEE-1394 based devices for the in-home network applies existing networks and protocols to new transport media. It extends the range of applications for these devices without the necessary deployment of a PC. The architecture makes it possible to move from a PC-centric architecture to a network-centric one using intelligent peripherals.

Figure 1 shows an implementation of an NIU with a cable modem connected to a head-end. It supports four kinds of interfaces to the in-home networks. Three of them support the USB protocol, while the fourth one supports an IEEE-1394 based network. The Phone Wire Modem transmits and receives data over the existing phone wires to an in-home WTN while the Coax Cable Modem performs this function to a CTN over the coax cable.

The simplicity of the CTN or WTN is depicted in Figure 2. These nodes are basically self-powered USB hubs with the upstream ports modified for the physical media they are attached to. An additional port makes it possible for a PC to gain access to the in-home network and to the head-end through the NIU.

SUMMARY

This paper recommends a new architecture for an integrated, multi-services communications system. The NIU functions as residential gateway to standard end-terminal devices connected to cable or wiring nodes at the end of existing in-home wires. Other functions of the NIU include concentration of the upstream messages received form nodes for transport back to the central office or cable head-end, and routing of in-home communications packets. The architecture deploys in-home nodes at the end of coax or phone wiring to interface to standard USB or IEEE-1394 based devices.

REFERENCES

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2) IEEE Std 1394-1995, IEEE Standard for a High Performance Serial Bus, December 1995.

3) VESA Home Network RFI, VESA Home Network Committee, 18 February 1997.

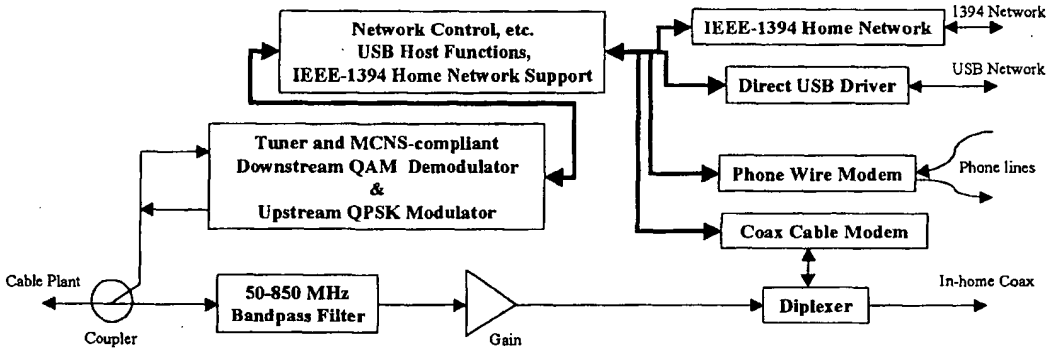

Figure 1. Network Interface Unit with Cable Modem and In-home Modems.

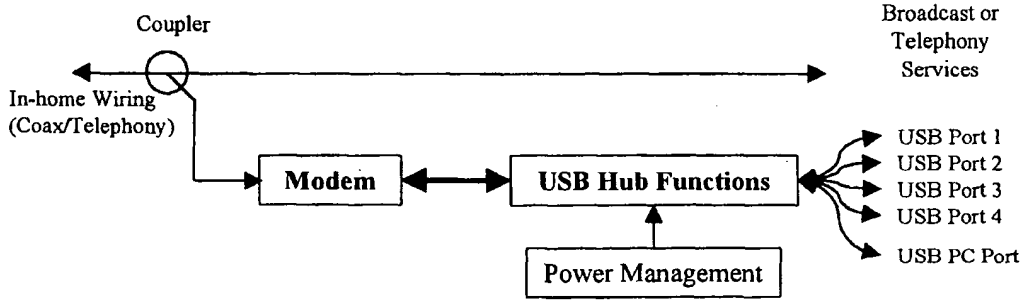

Figure 2. CTN/WTN with Four USB Downstream Ports and a PC Connection Port.